

# Educational Perspectives in the Ecological Paradigm - possibilities and limitations

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In principle, education depends upon the understanding of human beings. Ecological studies can give us opportunities to understand humans more clearly (or scientifically). This truth emphasizes the importance of ecological education. In ecology, a human being is a part of nature. This is because all living beings are members of ecological communities. Ecological research reveals that life creates the conditions for its own existence. If the aim of education is life lived to its fullest, education is to help us to live in optimal survival conditions which will lead to the consummate unfolding of our nature. At the very least, education in the ecological paradigm will allow us to understand the educational perspectives, possibilities and limits of today

Key words: ecological education, ecological studies, education in the ecological paradigm, educational perspective, survival condition

## Introduction

In *The Web of Life*, Fritjof Capra (1997) wrote that “during this century the change from the mechanistic to the ecological paradigm has proceeded in different forms and at different speeds in the various scientific field.” (p. 17) In this aspect, we can say that our educational world – from preK to postsecondary education - also falls into the ecological – or organismic - paradigm. There are many ecological aspects and realities in education around us today: Various programs in ecological education, schools, learning, experiences etc., in practice today. The numerous symptoms of environmental pollution and ecological crises that are complained about and reported hasten the necessity of ecological education.

The purpose of this study is to openly debate on our current educational practices from an ecological perspective

mainly regarded as environmental education or on various programs of the ecological education today. In ecology<sup>1</sup>, a human being is ‘a part of nature’. In particular, ‘Deep Ecology’ recognizes the intrinsic value of all living beings and views humans as just one particular strand in the web of life. “If the aim of education is life lived to its fullest” (Orr, 1992, p. 99), education is to help us to live as a part of nature. It must be the optimal survival condition for human beings. To this end, education - especially in the ecological paradigm - must maximize or optimize the unfolding of our nature. According to Dewey, “(educational) development is conceived not as continuous growing, but as the unfolding of latent powers toward a definite goal.” (Dewey, 1921, p. 65)

The emergence of the ecological paradigm owes to the development of natural sciences. They found the fact that each organism inclusively human beings lives interdependently in our universe and that the natural world is evolving and developing according to the ecological principle, i.e., the natural law. Education in the ecological paradigm should be designed and performed according to the living principles and attributes of the ecological system, i.e., the nature system.<sup>2</sup> The following four issues - openness, creativity, individuality

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and networking abilities - must be the representative problems in our education. Of course, this assumption can be a limitation of this paper.

In short, the four issues - openness, creativity, individuality and networking abilities - discovered as natures of human beings by ecological studies are our themes with which this paper will deal in discourse. This discourse will suggest to us the educational perspectives - possibilities and limitations - in the ecological paradigm today.

## Four Issues and Discourse

### *Openness*

Ludwig von Bertalanffy, an Austrian biologist, understood living structures as "*open systems*" (Bertalanffy, 1950). In open systems, energy is the resource.

"Energy can be transformed into movement, heat, light and tension. Energy can be regarded as the cause of all changes in the world." (Heisenberg, 1970, p. 44)

The primary source of energy flow is the sun: "Solar energy, transformed into chemical energy by the photosynthesis of green plants, drives most ecological cycles." (Capra, 1997, p. 299) There are production, reproduction, generation and metabolism of living beings in the flow of energy. There is no life without energy flow. It is a survival law that dominates our ecosystem. With energy flow the materials are also exchanged reciprocally. All living organisms belong, therefore, to the class of open systems (Nicolis & Prigogine, 1977).

"The organism is not a static system closed to the outside and always containing the identical components; it is an open system in a (quasi-) steady state... in which material continually enters from and leaves into the outside environment.' (Bertalanffy, 1968, p. 121)

Even a cell in our body is an open system with a flow of energy passing through it (Mainzer, 1997). The structure of the cell membrane is much more complicated than a simple oil film, since the cell has to take up some substances from its physical surroundings and discharge others (Cramer, 1993). In short, living things are open systems and continually exchange energy with organizational levels at smaller and larger scales

(McDonald, Cervero, & Courtenay, 1999). In the result, from the simplest bacterial cell to man, maintenance of life requires a continuous exchange of energy and matter with the surrounding world (Nicolis & Prigogine, 1977).

Bertalanffy established "recycling" (Capra, 1997, p. 177) as a key principle of ecology. Life and death coexists and all things are reproduced and renewed in the ecosystems. In "food chain" - named by Charles Elton in the 1920s - strong animals eat weak animals and grazers eat plants. Bacteria decompose the death into a gas and solids. They are absorbed by green plants again. Finally, they "make a complementary whole" (Gibson & Pick, 2000, p. 15). Here is no loss in nature.<sup>3</sup>

In James Lovelock's *Gaia hypothesis*, our Earth is alive. Lovelock considered Gaia theory as an alternative to the conventional wisdom that sees the Earth as a dead planet made up of inanimate rocks, ocean, and atmosphere, and merely inhabited by life (Lovelock, 1991). Gaia means a goddess of Earth and a vast system including bacteria that controls levels of atmospheric gases (Orr, 1992). In this hypothesis, living beings and non-living beings are connected mutually.<sup>4</sup> Ice (solid) is transformed into "vapor (gas)"<sup>5</sup> and water (liquid) through changes in Earth's temperature. In this natural principle, we can say that the transformation is essential for all things. We can no longer think of rocks, animals, and plants as being separate (Capra, 1997). In short, ecosystems are the results of physical, chemical, and biotic components of nature acting together in a structurally and functionally organized system (Mainzer, 1997). Each thing in ecosystems is not in isolation, but in circulation. Such circulation completes open systems. Life and environment is one thing, not separate, and people, as all life, are immersed in the one system (Botkin, 1994).

As long as we live in an open system, the openness must be the nature of our lives. In this aspect, education must develop the openness of students. To this end, our educational activities must first of all contribute to make open systems around students. In order to make open systems, we have educational possibilities in the ecological paradigm as follows:

Firstly, education is to be open to our society. It needs to accept social interests which include social realities, changes and reform. Secondly, education is to be open to our environment. It needs to accept environmental learning or ecological education which deals with environmental knowledge and ecological life. David W. Orr (1992) suggested *ecological literacy*: "Ecological literacy implies a broad understanding of how people and societies relate to

each other and to natural systems.” (p. 92) Daniel Botkin (1994), an American ecologist, also believes in this view: “The task before us is to understand the biological world to the point that we can learn how to live within the discordant harmonies of our biological surroundings” (p. 34). Thirdly, education is to be open to students' parents and guardians. It needs to allow for and appeal for their more active participation and cooperation. Fourth, there must be a mutual openness between educators and students. In short, education in the ecological paradigm should construct open systems in all directions and aspects.

However, openness in education has some limits. If our society and environment have already been corrupted and contaminated as J. J. Rousseau has asserted about 250 years ago, students could benefit more from social isolation.

“Rousseau’s statement that everything is good as it comes from the hands of the Creator has its signification only in its contrast with the concluding part of the same sentence: ‘Everything degenerates in the hands of man.’” (Dewey, 1921, p. 137-138)

Students could be so damaged as corrupted society and surroundings, if they always have an open mind to their society or if they are left as it stands in the open system. In brief, the environment consists of those conditions that promote or hinder, stimulate or inhabit, the characteristic activities of a living being (Dewey, 1921). Especially, “it is the business of the school environment to eliminate, so far as possible, the unworthy features of the existing environment from influence upon mental habitudes.” (Dewey, 1921, p. 24) Rather, the curriculum or texts in school as indirect experiences may stimulate the optimal openness of students.

“Much of our experience is indirect; it is dependent upon signs which intervene between the former... From the standpoint of the pupil, the resulting experiences are worth while on their own account: from the standpoint of the teachers, they are also means of supplying subject matter required for understanding of open-mindedness and concern as to the material symbolically conveyed.” (Dewey, 1921, pp. 271-273)

Education or educational intervention should make students to develop the abilities and capabilities to give them enough insight to criticize the corrupted and contaminated surrounding. It is, however, relevant we recognize ourselves

as a component of open society, even if society becomes the target of critique.

In principle, critique may not necessary be related to the openness. If our society, however, is truly corrupted, the earnest educational intervention has to focus on the social critique. This is because educational activities also relate to social reform and revision as an optimal condition. In this aspect, they say that the emergence of critical pedagogy must be the historical inevitabilities. However, such corruption or contamination of society and environment can not always be revised and reformed by critique alone. In some cases, critiques - especially one without the alternative - can be dangerous. In severe cases, critique can be domesticated.

“Undoubtedly, critique can be understood and should be promoted as a contribution to improved human judgment. The word <critique> is, however, often used for activities that are inclined to hinder or even damage the development of well-informed and well-reasoned judgment. In such cases, where critique is manipulated as an instrument of power over its addressees, critique is being 'domesticated'.” (Heid, 2004, p. 337)

In this aspect “critical pedagogy seems in a certain sense rather to have contributed to the immunization of society against critique.” (Blake & Masschelein, 2003, p. 55) In this case, education must do more to intervene than to mediate critical abilities of students. Nevertheless, the critique is not unconcerned about the other world. Thus, the critique can be a kind of the openness to our surroundings. In this sense, the critique could be a minimal condition in education for the openness. The educational principle in the ecological paradigm is to worry over what the open system can allow and include, even critique.

### ***Creativity***

Ecosystems are the only systems capable of stability in a world governed by the “laws of thermodynamics” (Orr, 1992, p. 35). The second law of thermodynamics says that all things are created from the beginning with the property of “entropy”<sup>6</sup>: the self-destroying and self-dying nature of materials and living things. According to the law of entropy, “it necessarily increases until the world ends in thermal death.” (Cramer, 1993, p. 189) Rudolph Clausius concluded that the “entropy of the universe is increasing” (Nicolis & Prigogine, 1977, p. 2). He defined the entropy generated in a

thermal process as the dissipated energy divided by temperature at which the process takes place (Capra, 1997). We burn a lump of coal, low entropy, and create ashes and heat, high entropy (Orr, 1992).

This law was speculated by Ludwig von Bertalanffy in the 1940s. He postulated that “in open systems the entropy may decrease, and that the second law of thermodynamics may not apply.” (Capra, 1997, p. 48) If we give a system a sufficient amount of negative entropy flow, we enable it to maintain an ordered configuration (Nicolis & Prigogine, 1977). That is to say, ‘negative entropy’ is generated through the continual inflow of energy and materials from the surroundings in open systems. In other words, the entropy can be offset by self-organizing activities in open systems. In this context, Erich Jantsch, an Austrian physician, explained our universe as a self-organizing paradigm; ‘*self-organizing universe*’ (Jantsch, 1980).

Ilya Prigogine in his theory of ‘*dissipative structure*’ as well as Humberto Maturana and Francisco Varela in their theory of “*autopoiesis*”<sup>7</sup> reported that “creativity - the generation of configurations that are constantly new - is a key property of all living systems” (Capra, 1997, p. 221). According to Capra, “our Earth is a self-generating system” (Capra, 1997, p. 215). Here ‘self-organization’ and ‘self-generation’ means ‘self-creation’. No living organisms can survive without self-creation.

In other words, an organism in equilibrium is a dead organism; “Living organisms continually maintain themselves in a state far from equilibrium, which is the state of life.” (Capra, 1997, p. 181) According to Erwin Schroedinger, “energy flow creates conditions that allow strong deviations from thermodynamic equilibrium.” (Mainzer, 1997, p. 97) Here “non-equilibrium may be a source of (new) order.” (Nicolis & Prigogine, 1977, p. 25)

How can such the phenomena take place? According to ecologists, it occurs through flows and activities of energy. That is, “energy is consumed” (Cramer, 1993, p. 37) in the transforming process as from chaos into (new) order as from order into chaos. Living organisms need to consume energy, “even in hibernation” (Cramer, 1993, p. 18). Energy allows chaos to be transformed into order. For example, the “butterfly effect”<sup>8</sup> creating slight chaos to a huge order materializes by a change of temperature (energy) in the air. Gas is transformed into water and ice through consumption of energy. Thus “throughout the living world chaos is transformed into order.” (Capra, 1997, p. 190) Fritjof Capra (1997) concludes that “order and disorder (chaos) are always created simultaneously in the living world.” (p. 189) Even

dynamical microscope systems take place in the order-disorder schema (Volkamer, Streicher, & Walton, 1996).

Ilya Prigogine, a Belgian Nobel Price Laureate, saw ‘order through fluctuation’ (Nicolis & Prigogine, 1977) and ‘order out of chaos’ (Prigogin & Stengers, 1984). He explained this process with his theory of “*dissipative structures* (1967)”<sup>9</sup>. Nicolis and Prigogine called them as the ordered configurations that emerge beyond instability of the “thermodynamic branch” (Nicolis & Prigogine, 1977, p. 60). Eduard Lorenz, an American meteorologist, diagrammed the phenomena with *the Lorenz attractor model* (1963). This attractor is “chaotic in essence” (Mainzer, 1997, p. 59), but has special patterns and structures.<sup>10</sup> In this aspect, we can say that there is the phenomenon of “creating chaos” in order of all living systems. Thus there is no life without creating chaos. As long as we live on creating chaos, the creativity must be the nature of our life.

In this context, we can say that all students as parts of the ecosystem also have inborn creativity and continue to survive thanks to their self-creating ability. Education must help or “*facilitate*”<sup>11</sup> the students to unfold this potential creativity. Thus there are educational possibilities in the ecological paradigm as follows:

Firstly, education is to allow for greater autonomy of students. The nature of *autopoiesis* enables them to be self-creative. Education must help or facilitate to develop creative potential in students, because they can not help creating their survival energy from birth. Ecologically speaking, “life creates the conditions for its own existence.” (Capra, 1997, p. 106) Secondly, education needs to allow more tolerance of the chaotic thoughts and behaviors of students as much as possible, as they in turn may lead to creative chaos.<sup>12</sup> Thus “the islands of order” (Cramer, 1993, p. 122) become larger and larger until only a few bands of chaos remain.

“If I were a teacher, I hope that I would be asking myself questions like this: ‘Do I have the courage and the humility to nurture creative ideas in my students? Do I have the tolerance and humanity to accept the annoying, occasionally defiant, occasionally oddball questions of some of those who have creative ideas? Can I make a place for the creative person?’...The educated professionals would not have wasted their time on such nonsense... I would like to be able to do that.” (Rogers, 1983, pp. 141-142)

Alfred North Whitehead said (1927): “All practical teachers know that education is a patient process...” (p. 6).

Thus, at the very least, education in an ecological paradigm, i.e. ecological or environmental education, will help students to develop their creative potential and abilities. In short, he must be a *helper* or *facilitator* for students' creative behaviors rather than a one-sided indicator.

However, if the creativity of human beings is not considered seriously, unexpected life situations and events could occur. Of course, it could lead to something new and creative. Nevertheless, 'creation is always apt to go with some destruction' (F. Nietzsche), adventure and risk. If the creativity in question continues to be sustained only in a status of destruction, adventure and risk, it may be wrong or worse creation. Such a creation is extremely dangerous and threatening. In this aspect, education should worry about what the desired creative activities could be. It relates to the desired objectives of creation and creative activities. It must also be relevant to design the educational objectives and directions of creation in education. In other words, creativity itself can be an inborn nature of human beings, but not always positive and educational. Of course, the recognition of potential creativities in human beings must be the first condition for creative education of *autopoiesis* in the ecological paradigm.

### **Individuality**

The conception of *homeostasis*, steady state and constancy, was introduced by Walter B. Cannon in his book *The Wisdom of the Body* (1932). As conditions, for example, move away from those suitable for life, biological organisms act to restore the balance (Axelrod, 1984). The restoration of balance here is performed by a function and ability of homeostasis. In his *General System Theory* (1942), Ludwig von Bertalanffy coined the term 'flowing balance' (Capra, 1997, p. 177) to express the coexistence of balance and flow, of structure and change in all form of life. Most ecologists today conclude that life is in flowing balance.

However, some ecologists such as Prigogine and Mainzer are not pleased with this conclusion. There are disturbances in the flowing balance of life. According to chaos theorists, the essence of living things is not stability, but unstable disorder or chaos. This is due to chemical actions and reactions in organisms that lead to organic fluctuation. Klaus Mainzer, a German philosopher and scientist, explained in his *Thinking in Complexity* (1997) that "a cell is considered as a bag of fluid with homogeneous chemical composition" (Mainzer, 1997, p. 99). The disturbance is generated by chemical actions and reactions in each cell. Thus "homeostasis in living systems" (Cannon, 1932, p. 32) does

not mean simple equilibrium without fluctuation.

Thousands of chemical activities differentiate and specialize the processes of organic metabolism. It means that all creatures keep on living in different ways, because of diverse chemical activities. Freeman Dyson, an English mathematician and physiologist, says that the greatest gift on our Earth is 'diversity' (Dyson, 1985). Diversity is generated and created by differentiation. Ecosystems are aggregations formed by numerous different and diverse living systems. Rather than seeing evolution as the result of random mutations and natural selection, ecologists are beginning to recognize the creative unfolding of life in forms of ever-increasing diversity and complexity as an inherent characteristic of all living systems (Capra, 1997).

Meanwhile, living organisms recognize their environment in different ways. This is due to the fact that "cognition results from a pattern of distinctions, and distinctions are perceptions of difference" (Capra, 1997, p. 305). For example, a microorganism reacts on various changes - light and shade, density of light, warmth and coldness etc. - from his environment.

"Even bacteria perceive certain characteristics of their environment. They sense chemical differences in their surroundings and accordingly swim toward sugar and away from acid; they sense and avoid heat, move away from light or toward it and some bacteria can even detect magnetic fields" (Magulis & Sagan, 1995, p. 179).

Francisco Varela regards cognition as embodied action (Varela et al., 1991, p. 200). According to Maturana and Varela, cognition is an instinct of living organisms (Maturana & Varela, 1980). In their Santiago theory, cognition is an integral part of the way a living organism interacts with its environment (Capra, 1997)

"An ecological orientation is interactive and very much in this word: in it, development involves making the world one's own and becoming a person in the process." (Bronfenbrenner, 1981, p. 289)

Living systems are cognitive systems and living as a process is "a process of cognition" (Maturana, 1970, p. 162). In addition, "cognition is not a representation of an independently existing world, but rather a continual bringing forth of a world through the process of living." (Capra, 1997, p. 267) The world everyone sees is not the merely world, but a

world in which we bring forth with others (Maturana & Varela, 1987).

Birds recognize their surroundings differently from dogs. And cats or birds will see trees very differently from the way we do, because they perceive light in different frequency ranges (Capra, 1997). Thus all human beings are different because of their diverse cognition. Differentiated cognition determines diverse individuality. If so, diverse and differential individuality must be the nature of our lives.

In the result, each student has also his own individuality distinguished and differentiated from others. Thus education must help or facilitate him to develop the individual potential and unique properties that determine his own individuality. There are educational possibilities in the ecological paradigm as follows:

Firstly, education is to give more chances for students to directly experience their interests, concerns and favorites as John Dewey has already emphasized: '*learning by doing*'. "Ecological ways of knowing nature are necessarily participatory" (Shiva, 1994, p. 36), because "experience in the natural world is an essential part of understanding the environment" (Orr, 1992, p. 91). Secondly, education is to regard and respect a student as an owner of individuality. According to R. W. Emerson and J. J. Rousseau, a child (student) is not a miniature of an adult, but a person with his own individuality. According to Leopold, "the essence of ethics is respect for the biotic community as such." (Leopold, 1971, p. 204) Thus education should respect student's individual talent, aptitude, character, temperament, interest and so on.

However, 'general education' can not be deleted or completed by individual education. The former as the whole is not the sum of the latter. In a maxim discovered in hermeneutics, the whole is more than the sum of its parts. We must not lose the chance to do general education in emphasizing upon only the diversity and differentiation of individualities.

"The individualism is a product of the relaxation of the grip of the authority of custom and traditions as standards of belief... For various reasons, however, the new individualism was interpreted philosophically not as meaning development of agencies for revising and transforming previously accepted beliefs, but as an assertion that each individual's mind was complete in isolation from everything else. In the theoretical phase of philosophy, this produced the epistemological problem: the question as to the possibility of any

cognitive relationship of the individual to the world. In its practical phase, it generated the problem of the possibility of a purely individual consciousness acting on behalf of general or social interests, – the problem of social direction." (Dewey, 1921, p. 356)

Thus education in the ecological paradigm should consider and worry about the harmony and balance between individuality and generality (universality) of students, too. The generality in our ecosystem is the umbrella concept that includes individuality.

### ***Networking abilities***

The theory of co-evolution is based on symbiotic evolution. Symbiosis occurred around 2.2 billion years ago and led to the evolution of *eukaryotic* ('nucleated') cells, which became the fundamental components of all plants and animals (Capra, 1997). However, the theory of co-evolution is more than a simply evolutionary process. Even an organism creates its environment in co-evolutionary development. That is, since the creation of the first nucleated cells, evolution has proceeded through ever more intricate arrangements of cooperation and co-evolution (Capra, 1997). In their Gaia theory, James Lovelock and Lynn Margulis modified Darwin's concept of evolution:

"Throughout the living world evolution cannot be limited to the adaptation of organisms to their environment, because the environment itself is shaped by a network of living systems capable of adaptation and creativity. So, which adapts to which? Each to the other - they co-evolve" (Capra, 1997, p. 227).

In a word, life had moved another step, beyond "the networking of free genetic transfer to the synergy of symbiosis" (Margulis & Sagan, 1986, p. 119).

In the 1920s, ecologists focused on functional relationships within animal and plant communities (Ricklefs, 1990). From the beginning, new flowering plants co-evolved with animals, which enjoyed eating their nutritious fruits and in exchange disseminated the undigested plant seeds (Capra, 1997). Thus Lovelock's belief is that "evolution legitimately applies to the planet more than to separate species" (Lovelock, 1988, p. 19). That is to say, so closely coupled is the evolution of living organisms with the evolution of their environment that together they constitute a single evolutionary process (Lovelock, 1991). Everything on our earth is formed in a

complex manner in the process of co-evolution. To be precise, “the structures and processes of living systems interact and form a network” (Cramer, 1993, p. 5). In this sense, Bernard C. Patten (1991) says that ecology is a network: “To understand ecosystems ultimately will be to understand network” (p. 19).

After Bateson's work in the 1970s, ecologists started to understand the essence of life as a 'relationship'. This relationship is explained from the nonlinear structure of 'genes'<sup>13</sup>:

“The genome is not a linear array of independent genes but a highly interwoven network of multiple reciprocal effects mediated through repressors and derepressors, exons and introns, jumping genes, and even structural proteins.” (Varela et al. 1992, p. 188)

All living organisms do not survive with their own functions, but with nonlinear relationship between their functions and roles. The nonlinear relationships appear in the form of network patterns.

Nonlinear relationship is not developed in an up-and-down dimension, but horizontally or laterally. In nature, there is no hierarchy of up-and-down constructed by human rationality: “Nature is neither good nor bad, neither peaceful nor militant.” (Mainzer, 1997, p. 320) Nature is neutral and necessary without exception for our life. In ecosystems human beings are neither centers nor owners of nature. A man is regarded as just one particular strand in the web of life.

“Whereas the old paradigm is based on anthropocentric (human-centered) values, deep ecology is grounded in eco-centric (earth-centered) value.” (Capra, 1997. p. 11)

In our body the tooth is not more valuable than the stomach. Each part in an organism is necessary and valuable respectively. One living being does not dominate the other in nature. All living systems are wholly connected and related in a nonlinear network laterally.

Margulis and Sagan said, “Life did not take over the globe by combat, but by networking.” (Margulis & Sagan, 1986, p. 15) The reasonable hierarchical system in our society differs from the ecosystem of “*holarchy*”<sup>14</sup>. We have formed the hierarchical (social) system compulsorily with the help of our rationality in order to easily dominate and control the others (nature and human). Human societies are therefore very

different types of living systems (Capra, 1997). Thus the system of position-searching competition in our hierarchical society is not related to the nature of ecosystems. By recovering the living principle accordingly the nature of ecosystems, ecologists call for a paradigm shift “from hierarchies to networks” (Capra, 1997, p. 10). Eduard deBono believes that a promising society in the future can be '*a lateral society*' (deBono, 1973). In this aspect, it is irrevocable to restore the lateral relationships in nonlinear networking. If so, the networking must be recognized as a nature of our life.

In ecology, a student as a part of ecosystem is related to others by networking. Thus education should help or facilitate each student to have the ability to develop relationships through networking. From this point of view, there must be educational possibilities in the ecological paradigm as follows:

Firstly, education is to recognize the principle of coexistence that results from symbiosis and co-evolution. Here is only a lateral relationship between educators and students. As Bronfenbrenner (1981) says, “the main effects are in the interaction.” (p. X) That is to say, educators and students are partners in the networking interaction. Educational interaction can be created in networking of all. Therefore, it is important that we make a networking partnership or membership in interaction among teachers, learners and parents and educational experts, practitioners, and so on in an educational community.

In this sense, ecological research shows that the interactive and networking cooperation of partners will be more important than a keen competition among them in future society. Secondly, education should enrich classes in the two-way dialogue or “communication”<sup>15</sup> that makes mutual interaction and relationships. In general, the communication which insures participation in a common understanding is one which secures similar emotional and intellectual dispositions – like ways of responding to expectations and requirements (Dewey, 1921). The communicative ability of students must be an important task of our education. Thirdly, education is also to be able to make students understand that “the new ethic in the ecological paradigm means mutual benefits” (Gouldner, 1959, p. 249) acquired by our networking ability. In general, education can apply the communicative method of dialogue as an educational interaction for developing the networking ability naturally.

However, dialogue itself is not always educationally valuable. Worse dialogue or communication can often bring about severe misunderstanding between speaker and listener. If we want to realize education for developing the networking

ability of students, we should first of all consider which networking could be educationally valuable. That is to say, we can not say that it is educational to believe in networking ability of students or to give classes in dialogue itself. Instead it is more relevant to show 'why' or 'what for?' students should communicate or dialogue each other in order to develop the networking ability. It is also more educational to show which method of dialogue is more effective and efficient in the educational dimension. In addition, education needs to worry about showing students the desired relationship and networking between men and materials (especially computer, machines, and technologies), man and man, men and women - and perhaps occasionally between human and god - , if it will play an appropriate role in the ecological paradigm as well.

### Conclusion

We have understood and discoursed education or educational perspectives in the ecological paradigm with four issues as human natures that were discovered scientifically by ecological studies until now. In the ecological paradigm, there can be educational possibilities and limits for openness, creativity, individuality and networking that the ecological studies - although they are limited on our paper - discovered as human natures. Education is, in principle, based on human nature. However, it can be unfolded and developed by special intervention or intentional activities in the educational dimension, whether it is ecological education or not.

“There is a marked difference between the education which every one gets from living with others, as long as he really lives instead of just continuing to subsist, and the deliberate educating of the young. In the former case the education is incidental; it is natural and important, but it is not the express reason of the association... But in dealing with the young... the need of training is too evident; the pressure to accomplish a change in their attitude and habits is too urgent to leave these consequences wholly out of account. Since our chief business with them is to enable them to share in a common life we cannot help considering whether or no we are forming the powers which will secure this ability.” (Dewey, 1921, pp. 7-8)

In short, education must not be *laissez-faire*. In this sense, Rousseau's view of “negative education” is also

excluded from our study.<sup>16</sup>

Now, there remains the problem of ‘value’ in an educational intervention.<sup>17</sup> With a wrong or undesired intervention and non-educational intention, for example, there can be worse effects or destructive and negative degeneration. Thus, we must focus on the following question: Why or how should we intervene in the process of unfolding human nature educationally? Of course, the remaining solution will depend on the will and attitude of students that receive the ecological perspectives. Learning is facilitated when the students participate responsibility in the learning process (Rogers, 1969). In other words, significant learning takes place when the subject matter is perceived by the students as having relevance for his own purpose (Rogers, 1969). Thus the educational value today should be defined and determined in relation to the point of view of students.

Today, the needs for ecological education or programs are increasing very rapidly. If future education must be redesigned and directed ecologically, ecological knowledge and discoveries can contribute to renew, revise or develop the educational perspectives in the ecological paradigm. Nevertheless, we need to continue the traditional debate over ‘the educational value’ in the hypothetical ecology. Thus, we need to accept a hypothesis of the ecological paradigm in education ‘only with some limits and consideration,’ as we have checked and illustrated in this paper so far. In addition, the practices and fields of ecological education also need to severely consider and reflect on the educational perspectives - possibilities and limitations - that result from such kinds of continuing studies as this one.

In short, it can be problematic to apply the ecological aspects to the educational realities without reflecting the possibilities and limitations. Thus, education should deliberate on introducing the ecological paradigm as a new one even though it can be relatively appropriate for all aspects of the real life today. If the ecological paradigm must be also applied to the educational realities in the same way without exception, we need no longer to make any educationally valuable intention and willingness. All occur naturally, inartificially, self-organically, and systematically in the ecological paradigm without any externally intentional and purposeful intervention. In this aspect, it may be an optimal aim of education to facilitate self-directed learning that maximizes trustworthiness of human nature.<sup>18</sup> Nevertheless, it must be more important for educators to educate and teach students the educational value with an intention and willingness as educational intervention, since “non-resistance to evil (or wrongdoing) which takes the form paying no attention to it is a way of

promoting it" (Dewey, 1957, p.19).

## Notes

1. Ecology emphasizes a holistic study of both parts and wholes (Odum, 1997, p. 34).
2. Education in the ecological perspective seems to bear some resemblance to *scientific pedagogy*. Montessori spoke for *scientific pedagogy* that prepared teachers through long and patient exercises for the observation of nature: "We wish to awaken in the mind and heart of the educator an interest in natural phenomena to such an extent that, loving nature, he shall understand the anxious and expectant attitude of one who has prepared an experiment and who awaits a revelation from it." (Montessori, 1964, p. 9) Of course, it was Montessori's eternal belief that the thing which we should cultivate in our teachers is more the (scientific) spirit than the mechanical skill of the scientist." (Montessori, 1964, p. 9) John Dewey also stood for the "science of human nature" (Dewey, 1957, p. 9).
3. In this process, bacteria play a crucial role, influencing the rate of chemical reactions and thus acting as the biological equivalent of the enzymes in a cell (Capra, 1997, p. 214).
4. Ecology is the science of how these living and nonliving components function together in nature (Mainzer, 1997, p. 106).
5. As time increases the gas will very rapidly tend to occupy the whole volume and destroy the initial order (Nicolis and Prigogine, 1977, p. 22).
6. The term represents a combination of "energy" and "tropos", the Greek word for transformation, or evolution. The term "entropy" was reintroduced and recovered to explain the second law of thermodynamics by Rudolph Clausius in 1865 (Mainzer, 1997, p. 85). According to the second law of thermodynamics, entropy keeps increasing as the thermal process continues; the dissipated energy can never be recovered, and this direction toward ever-increasing entropy defines the arrow of time (Capra, 1997, pp. 185-186).
7. This is a new term invented by Humberto Maturana and Francisco Varela in 1970s. Auto, of course, means "self" and refers to the autonomy of self-organizing systems; and poiesis - which shares the same Greek roots as the word "poetry" - means "making." So autopoiesis means "self-making." (Capra, 1997, p. 97)
8. Eduard Lorenz explained the chaotic phenomena in butterfly effect in the 1960's: The flap of a butterfly's wings in Brazil does set off a Tornado in Texas (Volkamer/ Streicher/ Walton, 1996, p. 109).
9. Prigogine combined "dissipative" and "structure" to express the two seemingly contradictory tendencies that coexist in all living systems. However, Prigogine's concept of a dissipative structure goes much further than that of an open system, as it also includes the idea of points of instability at which new structures and forms of order can emerge (Capra, 1997, p. 180). In any case, the link between physical-chemical systems and biological structures can be modeled by dissipative structures which may be involved in living systems (Mainzer, 1997, p. 98).
10. The strange attractor of Lorenz has the fractal dimension (Mainzer, 1997, p. 59).
11. Carl Rogers (1983) regarded the aim of education as *the facilitation of learning* (p. 121). Of course it means *the facilitation of significant and meaningful learning*.
12. Self-organization processes are also in far-from-equilibrium conditions (Prigogine and Stengers, 1984, p. 176). The chemical equilibrium is upset and destroyed in our Earth continually. However chemicals do not combine randomly, but in an ordered, patterned way (Margulis and Sagan, 1986, p. 51).
13. Genes are the smallest material units of inheritance, the atoms of inheritance (Cramer, 1993, p. 56). Each gene represents a functional unit, which is optimally adapted to the special purpose of its environment (Mainzer, 1997, p. 94).
14. Andreas Ninck, Leo Buerkei, Roland Hungerbuehler, Heinrich Muehleemann, the Austrian system theorists used the "Holarchie" as a contrary concept of Hierarchy (Ninck et al. 2001, p. 50). Holarchie means the structural form of natural systems or ecosystems in which the same valuable components are assembled without loss.
15. Communication is one of the energy exchange mechanisms between an individual and other organizational scales (McDonald et al., 1999, p. 8).
16. Even Montessori well-known for a Rousseau's principal follower did not always sympathize with Rousseau's educational concept: "It is true that some teachers, led by Rousseau, have laid down fantastic principles with respect to a child's freedom and have expressed their confused desires for it, but the true concept of liberty is practically unknown to professional education." (Montessori, 1967, p. 9) John Dewey also wrote: "The point may be summarized by saying that Rousseau was right, introducing a much-needed reform into education, in holding that the structure and activities of the organs furnish the conditions of all teaching of the use of the organs; but profoundly wrong in intimating that they supply not only the conditions but also the ends of their development... Rousseau's passionate assertion of the intrinsic goodness of all natural tendencies was a reaction against the prevalent notion of the total depravity of innate human nature, and has had a powerful influence in modifying the attitude towards children's interests. But it is hardly necessary to say that primitive impulses are of themselves neither good nor evil, but become one or the other according to the objects for which they are employed. That neglect, suppression, and premature forcing of some instincts at the expense of others, are responsible for many avoidable ills, there can be no doubt." (Dewey, 1921, p. 133-134)
17. The specific values usually discussed in educational theories coincide with aims which are usually urged: They are such things as utility, culture, information, preparation for social efficiency, mental discipline or power, and so on (Dewey, 1921, p. 271). Carl

Rogers (1983) confessed that the humanistic and person-centered institution that permitted the maximum freedom to self-directed learn for students failed to survive (p. 245). He saw the reason of such failure in the problem of values (p. 255), especially the issue of the universality of values (p. 267). Of course, he pointed out that both personal and social values emerge as natural, and experienced, when the individual is close to her own organismic valuing process (Rogers, 1983, p. 267) : “Human have within themselves an organismic basis for valuing. To the extent that we can be freely in touch with this valuing process in ourselves, we will behave in ways that are self-enhancing... I have conclude that a new kind of emergent universality of value directions becomes possible when individuals move in the direction of psychological maturity, or more accurately, move in the direction of becoming open to their experiencing.” (Rogers, 1983, p. 268)

18.C. Rogers is a representative advocate for self-directed learning in this context: “I have little sympathy with the rather prevalent concept that persons are basically irrational, and thus their impulses, if not controlled, would lead to destruction of others and self.” (Rogers, 1983, p. 292)

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